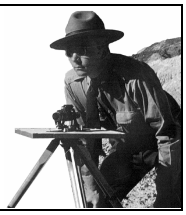
GEOLOGIC RESOURCE MONITORING PARAMETERS

Stream Sediment Storage and Load



Brief Description: The load (discharge, tonnes/year) or yield (tonnes/km2/year) of sediment (in suspension and as bed load of sand and gravel) through stream (river) channels reflects upland erosion within the drainage basin and change in storage of sediment in alluvial bottomlands [see soil and sediment erosion]. In turn, this is influenced by climate, vegetation, soil and rock type, relief and slope, and human activities such as timber harvesting, agriculture, and urbanization. Much of the sediment eroded from upland areas is deposited (stored) on lower hillslopes, in bottomlands, and in lakes and reservoirs. In terms of sediment budget, net erosion = total denudation - sediment storage + channel erosion, where denudation is a measure of regional upland erosion. Flash floods in ephemeral desert streams may transport very large sediment loads, accounting for unforeseen sedimentation problems in dryland stream reservoirs.

Significance: Sediment load determines channel shape and pattern [see stream channel morphology]. Changes in sediment yield reflect changes in basin conditions, including climate, soils, erosion rates, vegetation, topography and land use. Fluctuations in sediment discharge affect a great many terrestrial and coastal processes, including ecosystem responses, because nutrients are transported together with the sediment load. For example, to reproduce effectively, salmon and trout need gravel stream beds for spawning and egg survival; silt and clay deposits formed by flooding or excessive erosion can destroy these spawning beds. Stream deposits also represent huge potential sinks for, and sources of, contaminants.

Environment where Applicable: Fluvial systems

Types of Monitoring Sites: Stream channels where evidence of erosion or sedimentation is available and where local observations can be extrapolated to larger areas.

Method of Measurement: Periodic sampling of suspended sediment to determine its concentration, combined with periodic coring of bed load to determine the rate of storage, and measurement of bedload flux (discharge). Sampling should be carried out at enough sites to provide estimates of volume, and should be supported by direct examination of stream margins, cutbank exposures and overbank deposits. Where more quantitative data are not available, studies of changes in biomass distribution (especially woody plants) can provide reliable qualitative measures of hydrologic and geomorphic events over the past several hundred years.

Frequency of Measurement: Daily, or often enough to obtain a continuous record of changes. Measurements of sediment storage at least once every 5 years.

Limitations of Data And Monitoring: Bedload is difficult and expensive to measure, and is rarely monitored. The deepest parts of streams are hard to sample. The effectiveness of stream sediment storage and load as an indicator is strongly dependent on a well-designed, systematic monitoring network. Sediment discharge may increase or decrease due to natural cycles of stream development under conditions of stable climate.

Possible Thresholds: NA

Key References:

Guy, H.P. & V.W.Norman 1970. Field methods for measurement of fluvial sediment. US Geological Survey Techniques of Water Resources Investigation, Book 3, Chapter C-2.

Osterkamp, W.R. & S.A.Schumm 1996. Geoindicators for river and river-valley monitoring. In Berger, A.R. & W.J.Iams (eds). Geoindicators: Assessing rapid environmental changes in earth systems:83-100. Rotterdam: A.A. Balkema.

Vanoni, V.A. (ed) 1975. Sedimentation engineering. New York: American Society of Civil Engineering Press.

Wolman, W.G. & H.C.Riggs 1990. Surface water hydrology. The Geology of North America Volume 0-1, Boulder, Colorado: Geological Society of America. (especially paper by Meade, R.H., T.R.Yuzyk & T.J.Day Movement and storage of sediment in rivers of the United States and Canada, p255-280).

Related Environmental and Geological Issues: Stream sediment storage and load affects virtually all environmental issues in drainage basins and along coastlines fed by stream sediment. Stream sediments may affect, for example, the health of aquatic organisms, and the silting-up of reservoirs and harbours. They may also store chemical contaminants in 'chemical time bombs' which can be subsequently released into the environment by flood events or other disturbances.

Overall Assessment: Stream sediment storage and load is of extreme importance in determining the transport of erosion products through and out of drainage basins.

Source: This summary of monitoring parameters has been adapted from the Geoindicator Checklist developed by the International Union of Geological Sciences through its Commission on Geological Sciences for Environmental Planning. Geoindicators include 27 earth system processes and phenomena that are liable to change in less than a century in magnitude, direction, or rate to an extent that may be significant for environmental sustainability and ecological health. Geoindicators were developed as tools to assist in integrated assessments of natural environments and ecosystems, as well as for state-of-the-environment reporting. Some general references useful for many geoindicators are listed here:

Berger, A.R. & W.J.Iams (eds.) 1996. Geoindicators: assessing rapid environmental change in earth systems. Rotterdam: Balkema. The scientific and policy background to geoindicators, including the first formal publication of the geoindicator checklist.

Goudie, A. 1990. Geomorphological techniques. Second Edition. London: Allen & Unwin. A comprehensive review of techniques that have been employed in studies of drainage basins, rivers, hillslopes, glaciers and other landforms.

Gregory, K.J. & D.E.Walling (eds) 1987. Human activity and environmental processes. New York: John Wiley. Precipitation; hydrological, coastal and ocean processes; lacustrine systems; slopes and weathering; river channels; permafrost; land subsidence; soil profiles, erosion and conservation; impacts on vegetation and animals; desertification.

Nuhfer, E.B., R.J.Proctor & P.H.Moser 1993. The citizens' guide to geologic hazards. American Institute for Professional Geologists (7828 Vance Drive, Ste 103, Arvada CO 80003, USA). A very useful summary of a wide range of natural hazards.